51. (Currently Amended) ~~The electric terminal~~ The semiconductor device according to claim 1, wherein said support member is made by etching and partially surrounds said lead member.

REMARKS

Claims 1-23 and 46-51 are all the claims presently pending in the application. The drawings stand objected under C.F.R. 1.83(a) as allegedly not showing every feature of Claims 4, 14, 17 and 18. ~~Claim 48 stands rejected upon informalities (e.g., 35 U.S.C. § 112, second paragraph).~~ Claims 1-23 and 46-51 stand rejected on prior art grounds. Reconsideration is respectfully requested.

Claims 1, 2, 4, 5, 8-11, 15-23, 46-49 and 51 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Houtz (U.S. Patent No. 6,358,068). Claim 50 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Houtz. Claims 3, 6, and 7 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Houtz in view of Beroz et al. (U.S. Patent No. 6,329,605). Claims 12-14 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Houtz in view of Applicant's Prior Art Figure 1D.

These rejections are respectfully traversed in view of the following discussion.

It is noted that the amendments are made only to more particularly define the invention and not for distinguishing the invention over the prior art, for narrowing the scope of the claims, or for any reason related to a statutory requirement for patentability.

It is further noted that, notwithstanding any claim amendments made herein, Applicant's intent is to encompass equivalents of all claim elements, even if amended herein or later during prosecution.

Early favorable prosecution on the merits is respectfully requested.

I. THE CLAIMED INVENTION

Applicant's invention, as disclosed and claimed, for example by claim 1, is directed to **a** semiconductor device for use on a printed circuit board.

The semiconductor device includes a semiconductor chip having a thermal expansion coefficient different from a thermal expansion coefficient of the printed circuit board, a lead member connected to the semiconductor chip, an external electrode for electrically connecting the lead member with the printed circuit board, and a support member disposed on the semiconductor chip to surround the lead member. The support member contacts the external electrode at least upon application of an external thrust force which deforms the lead member. (See Page 8, lines 17-22; Page 10, line 23-Page 11, line 23; and Figures 4-5). This is important for reducing cracking in a solder ball.

In conventional electronic terminals, "a solder ball formed on an electronic device is mounted on a pad of a printed circuit board, and is melted thereon for bonding," without any separate support member. However, the conventional structure tends to form cracks in the solder ball during the heat cycle test, and thus reduces the reliability of the connection. (See Page 1, line 15 - Page 2, line 12; and Figures 1 and 2).

An aspect of the invention includes a support member contacts the external electrode at least upon application of an external thrust force which deforms the lead member, which permits the external electrode to "move[d] in a horizontal direction during the heat cycle due to the flexibility of the lead member and the support member without damaging the electronic connection, and thereby reduce cracking in the solder ball." (Page 7, lines 15-25; and Page 11, lines 20-23).

As a result, the inventive structure improves "the reliability of the electric connection against

damage by the thermal stress and the mechanical strength necessary for handling and testing the electronic device." (See Page 5, lines 18-25; and Page 8, lines 1-9).

II. 35 U.S.C. § 112, Second Paragraph, Rejection regarding Claim 48

Applicant has amended claim 48 in a manner believed fully responsive to all points raised by the Examiner. For the Examiner's greater clarity, he is referred to the specification, at Page 5, lines 18-25; and Figures 3-5. In view of the foregoing, the Examiner is respectfully requested to withdraw this rejection.

III. THE PRIOR ART REJECTIONS

A. The § 102(b) Rejection Based on Houtz

Houtz fails to teach or suggest, a support member contacts with the external electrode at least upon application of an external thrust force which deforms the lead member. (Page 11, lines 20-23; and Figures 4-5).

Figures 1, 2, and 13 of Houtz merely disclose a high-density electrical I/O connector capable, which is different from the claimed semiconductor device chip and printed circuit board. The electrical connector includes a signal contact 84 with an upper section and a medial section 92, which passes through the lower wall of a receptacle and a lower section 98 that extends "into the outer recess 22 for example, recess, where a solder ball 100 is fused to lower section." Adjacent to the lower wall are lateral walls or side portions of the base wall, 14.

According to the present invention, the semiconductor device has the support member 14 to surround the lead member 13. The support member 14 functions as a bumper to absorb a thermal expansion stress due to a difference in the thermal expansion between the semiconductor chip 11 and the printed circuit board 15.

Houtz neither teaches nor suggests the structure of the claimed invention.

Indeed, contrary to the assertion in the Office Action, the base wall 14 is in contact with the

solder ball 100, regardless of an application of a force, and accordingly is functionally and structurally different than Applicant's support member, which contacts an external electrode at least upon application of an external thrust force. (See Office Action, Page 4, lines 2-3; Houtz at Abstract; and Column 5, lines 20-35). Specifically, the signal contact 84, i.e, the lead member, along with a rib 498 are designed to deform to absorb stresses.

However, Houtz does not anywhere teach or suggest that the base wall 14 is deformable or flexes to absorb any of the applied stresses. In fact, Houtz teaches the opposite as, "[t]here was no noticeable warping or bending of the housing." Therefore, Houtz's structure of a high-density electrical I/O connector is different from Applicant's semiconductor device including a semiconductor chip and printed circuit board. (See Column 15, lines 20-25).

In contrast, as indicated above, in Applicant's invention (e.g., as defined in Claim 1), a semiconductor device 11 for use on a printed circuit board 15 purposely and affirmatively includes a support member 14, which contacts with an external electrode 12 at least upon application of an external thrust force which deforms a lead member 13. (See Page 8, Lines 10-16). The support member 14 surrounds the lead member 13 and is disposed on the semiconductor chip 11, which functions to "prevent[ing] an excessive deformation of the lead member 13 during an electrical test step of the electronic device, where[in] the solder ball 12 is applied with a thrust force by a probe pin, by maintaining the location of the solder ball 12 within a specified range." (See Page 7, lines 15-23). Accordingly, the support member 14 contacts the external electrode 12, for example, a solder ball, to move in a horizontal direction during the heat cycle, i.e., due to an external thrust force, which deforms the lead member 13 without damaging the electronic connection. Thus, cracking in the solder ball is reduced. (Page 7, lines 15-25; and Page 11, lines 20-23).

Thus, Houtz does not teach or disclose the above features of Applicant's invention. Indeed, Houtz teaches away from the invention and is focused on an electrical connector to reduce warping

or twisting of a thermoplastic insulative housing of the connector due to stresses generated when "soldering connectors to a substrate." (See Houtz at Abstract; and Column 2, lines 5-56). Accordingly, the Houtz configuration, which related to a high-density electrical I/O connector not a semiconductor device, only absorbs stress through deformation of the connector or a rib as the basewall is in contact with the solder ball regardless of an application of a force, whereas Applicant's invention, i.e., a semiconductor device including a semiconductor chip and printed circuit board, absorbs stress through a support member, which contacts the external electrode at least upon an application of an external thrust force. Therefore, in Houtz, like the conventional art, the solder ball situated at the end of the signal contact may likely crack during a heat cycle test.

Houtz, therefore, does not teach, suggest or disclose including a support member which contacts the external electrode at least upon application of an external thrust force which deforms the lead member.

For at least the reasons outlined above, Applicant respectfully submits that Houtz does not disclose, teach or suggest all the features of independent claim 1.

B. The § 103(a) Rejection of Claim 50 over Houtz

Regarding claim 50, Houtz, as discussed above, does not disclose, teach or suggest, including that a support member contacts with the external electrode at least upon application of an external thrust force which deforms the lead member, as recited in independent claim 1.

Further, Houtz does not disclose, teach or suggest, including the support member is separately disposed from the external electrode as recited in claim 50 of the invention.

Indeed, the Examiner admits that Houtz does not explicitly disclose the feature of claim 50. (See Office Action, Page 8, Section 10). Since Houtz (nor Beroz or the Prior Art) teaches or suggests this feature and the related function, it is clearly not obvious that one can just rearrange parts as suggested in the Office Action to yield Applicant's invention.

Since Houtz, as discussed above, does not teach or suggest including that a support member contacts with the external electrode at least upon application of an external thrust force which deforms the lead member as recited in Applicant's invention, Houtz is deficient, and thus does not teach the specific limitation of dependent claim 50.

For the reasons stated above, the claimed invention, and the invention as defined in dependent claim 50, is fully patentable over the cited reference.

C. The § 103(a) Rejection of Houtz in view of Beroz, et al.

First, the references, separately, or in combination, fail to teach, disclose or provide a reason or motivation for being combined.

Beroz, et al. ("Beroz") does not have the same aim as Houtz.

Beroz discloses a conventional micro-electronic assembly "incorporating soldered connections and [to] components incorporating pads for soldering," which includes a base having a non-solder wettable surface. (Column 3, lines 15-34). This configuration attempts to prevent solder flow in undesired locations and prevent displacement of solder from its desired location without the use of a solder mask "when processing an assembly." Thus, this configuration may "prevent solder from forming short circuits between adjacent pads, and may also act as a ground plane, power plane or shielding element." (See Beroz at Abstract; Column 1, lines 10-15 and 40-50; and Column 3, lines 15-55).

Nothing within Beroz which prevents undesired solder flow, suggests an electrical connector to reduce warping or twisting of a thermoplastic insulative housing of the connector due to stresses generated when "soldering connectors to a substrate" as disclosed in Houtz. Thus, Houtz teaches away from being combined with another invention, such as, Beroz.

Therefore, one of ordinary skill in the art would not have combined these references, absent hindsight. It is clear that the Examiner has simply read Applicant's specification and conducted a

keyword search to yield Houtz and Beroz. The Examiner provides no motivation or reason to combine other than to assert that it would have been obvious to one having ordinary skill in the art at the time to "use [an] external electrode that is out of contact with the support member of Beroz on the electrical terminal of Houtz in order to provide electrical isolation." (See Office Action at Page 8).

Second, even if combined, the references do not teach or suggest the features of independent claim 1, including that a support member contacts the external electrode at least upon application of an external thrust force which deforms the lead member.

Beroz does not make up for the deficiencies of Houtz.

Instead, Figures 1-6 of Beroz disclose a conventional micro-electronic assembly "incorporating soldered connections and [to] components incorporating pads for soldering." The pads 220b, 412 are recessed beneath the front surface of the base 212, 404. The pads 412 are exposed to the front surface 406 through apertures 408." Further, "a plurality of pads which are wholly or partially solder-wettable are exposed to such surface of the base... a nonsolder-wettable electrically conductive potential plane element overlies the surface in proximity to the pads but spaced from the pads so that there is a gap between each pad and potential plane element." "When the assembly is bonded to a circuit board or other substrate, or engaged in a socket, the same solder bump may connect both the pad and the potential plane element to an external source of ground or power potential." Accordingly, this configuration prevents solder flow from undesired locations and prevent displacement of solder from its desired location without the use of a solder mask. (See Column 4, lines 39-60; Column 6, lines 8-26; Column 8, lines 12-36; and Figures 1-6).

Indeed, Beroz teaches a solder ball on a pad without any suggestion of a thrust force, let alone, disclose, teach or suggest that the base or pad deforms in response to an external thrust force, particularly, during a heat cycle. The base 212, 404 (what the Examiner attempts to analogize to a support member) does not contact the solder mass nor support the solder mass, i.e., the external

electrode, even upon application of an external thrust force. Further, Beroz does not appear to teach or suggest any lead member. Accordingly, Beroz does not disclose, teach or suggest any support member, let alone, a support member, which contacts with the external electrode at least upon application of an external thrust force which deforms a lead member. (See Office Action, Page 9, line 2).

Therefore, neither Houtz nor Beroz teaches or suggests including a support member which contacts the external electrode at least upon application of an external thrust force which deforms the lead member as recited in claim 1.

For at least the reasons outlined above, Applicant respectfully submits that neither Houtz nor Beroz disclose, teach or suggest all of the features of the independent claim 1, and dependent claims 3, 6 and 7, which are patentable not only by virtue of their dependency from the respective independent claim 1, but also by the additional limitations they recite.

For the reasons stated above, the claimed invention is fully patentable over the cited references.

D. The § 103(a) Rejection of Houtz in view of Prior Art

Regarding claims 12-14, to make up for the deficiencies of Houtz discussed above, the Examiner relies on Applicant's Prior Art Figure 1D ("Prior Art"). The Prior Art fails to do so.

First, the Prior Art does not have the same aim as Houtz as discussed above, and the urged combination would not have been made, absent hindsight.

The Prior Art discloses a conventional flip-chip bonding structure where "a conductive spring or wire is used instead of the solder ball for achieving a higher density of the external terminals. The surface of the wire is coated with a thick plating for achieving a sufficient mechanical strength and resilience." (See Page 4, lines 4-8).

Indeed, the Prior Art attempts to improve the flip-chip bonding structure, including the reliability of the connection, and reduce cracking of the solder ball during a heat cycle test. (See Page

2, lines 7-12; and 21-23).

Nothing within the Prior Art, which focuses on reducing cracking of the solder ball during a heat cycle test, has anything to do with an electrical connector to reduce warping or twisting of a thermoplastic insulative housing of the connector due to stresses generated when "soldering connectors to a substrate" as disclosed in Houtz. Thus, Houtz teaches away from being combined with another invention, such as, the Prior Art.

Therefore, one of ordinary skill in the art would not have combined these references, absent hindsight.

Secondly, the Prior Art does not disclose, teach or suggest, a support member which contacts the external electrode at least upon application of an external thrust force which deforms the lead member as recited in claim 1.

Further, the Prior Art does not disclose, teach or suggest any member which includes a conductor bump at least a portion of which is made of solder as recited in claim 14.

Instead, the Prior Art discloses that the wire provides a mechanical strength and thus does not disclose, teach or suggest, including a support member, let alone, a support member which contacts the external electrode at least upon application of an external thrust force which deforms the lead member. Thus, the Prior Art is deficient and does not teach or suggest the limitations of dependent claims 12-14.

For the reasons stated above, the claimed invention, defined by dependent claims 12-14, is fully patentable over the cited references.

IV. FORMAL MATTERS AND CONCLUSION

In response to the 37 C.F.R. §1.83(a) objection raised to the drawings in the Office Action, Applicant has amended claims 4, 14, 17, and 18, in accordance with the Specification, which

eliminates the need to further modify the drawings. (See Specification, Page 7, lines 1-6; Page 8, line 23-Page 9, line 9; and Page 10, lines 12-16). It is noted that the Specification expressly indicates that "the lead member may be a conductor bump " (See Specification, Page 9, lines 6-9).

Second, regarding Figures 3B and 3C, the Applicant has amended both figures with the proper cross-hatchings in the attached "Replacement Sheets" to Figures 3B and 3C. In particular, in Figure 3B, element 20 has "conductive" properties and element 22 has "insulative" properties. Similarly, in Figure 3C, element 14 has "insulative" properties and element 30 has "conductive" properties.

Third, in response to the 35 U.S.C. § 132 objection in the Office Action, Applicant traverses the assertion that Figure 6 is not supported by the Specification. (See Office Action, Page 11, Section 13). Indeed, the Specification expressly indicates that an electric terminal 10 can be formed on an electronic device 11, where the electric terminal 10 includes a solder ball 12 or external electrode 12, an elongate lead member 13 and a support member 14. (See Specification Page 6, line 23-Page 7, line 6; and Page 16, Claim 23). This configuration is shown in detail in Figure 3, and more generally shown in Figure 6. Further, original claim 23 recited "an electronic instrument." Accordingly, no new matter has been added as Figure 6 as well as the original Figure 3, which are supported by the original specification. In view of the foregoing, Applicant respectfully requests that these objections be withdrawn.

Applicant has corrected the minor spelling error identified by the Examiner.

In view of the foregoing, Applicant submits that claims 1-23 and 46-51, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the

Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 11/25/03

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